IWMI
International Water Management Institute

Brief
Water for food - Africa

Increased water use for crop production in Africa: Policy implications

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Key messages

- The blue and green water consumption (WC) of crop production in Africa for the year 2020 amount to 119 and 1,087 km³ respectively. African crop production relies heavily on rainfed agriculture. Only a small fraction is irrigated.
- The crops with the highest total WC include rice, maize, cassava, groundnuts, sorghum, pearl millet and plantains.
- Blue water withdrawal (WW) for irrigation amounts to 225 km³, showing an African average irrigation efficiency of 53%, although irrigation efficiencies vary widely across regions and irrigation systems. Where they are low, they should be increased.
- The crops with the highest blue WW include rice, sugarcane, wheat, maize, tropical fruit, vegetables, groundnuts, and cotton.
- Both blue and green WC have increased Africa-wide from 2010 to 2020, especially for the crops cassava, groundnuts, maize, plantains, rice and yams, resulting in more food production. This was driven by an increase in harvested area during that period, often through deforestation. Blue WW increased by 25%, with large increases for rice, maize, groundnuts, sugarcane, fruits and vegetables.
- Increased crop water use puts additional pressure on available water resources, such as in the Nile, Niger and Zambezi basins, raising potential competition for water with other stakeholders, such as drinking water, manufacturing industry, electricity, livestock and mining.
- An open access database on crop specific WC amounts and the model to compute them are published in the high profile scientific journal Nature Food (Chukalla et al. 2025a, 2025b), freely available to all
- In order to produce more crops, there is large potential to close crop yield gaps and reduce climate risk of rainfed crop production by expanding irrigation, yet this needs to be done in a water-smart way, accounting for local water availability and the water demand of other sectors. Crop area expansion should be reduced to a minimum.
- Agricultural policies require nexus thinking to drive collaboration among sectors and institutions and should be data and science based.

Rice farmers working on rice terrace fields in central Madagascar (*photo:* Oliver Sommer)

Summary

Africa needs to increase food production to feed a growing population with a healthy nutritious diet (Rockström et al. 2025). Food production depends on limited available water resources. Many African regions already face water scarcity today, as not only agriculture needs water but also other sectors (Vanham et al. 2021). For informed decision making it is imperative to know how much water is used for African food production. A new IWMI led study finds that African crop production amounts to a blue and green water consumption (WC) of 119 and 1,087 km³ respectively for the year 2020, showing a high dependency on rainfed agriculture. Blue water refers to water in rivers, lakes, wetlands and aquifers. Green water is the soil water originating from precipitation. The study provides crop WC amounts for 46 different crops in a spatial resolution of 10 kilometers, that can be aggregated to (sub)national or river basin level. All results and the model to compute them are freely available to any stakeholder(Chukalla et al. 2025a, 2025b). The researchers found that blue and green WC have increased in Africa from 2010 to 2020, while producing more food, driven by an increase in harvested areas, leading to additional pressure on limited water resources in African river basins. Overall, crop water productivity has increased during this period. Crop yields generally remain low though and should be increased on existing agricultural lands to avoid agricultural land expansion at the expense of natural ecosystems. Expansion of irrigation is an important strategy to increase yields and make African crops more resilient to climate change, accounting for local water availability and the growing demand of other sectors. African average irrigation efficiency of blue water is with 53% rather low and should be increased. Strategies should account for the different water footprints of crops and critically evaluate the costs and benefits of cash crop exports outside Africa. Policies related to crop production need to embed nexus thinking and should be data and science based.

Africa needs to increase food production, yet data on the water use for food production are scarce, hampering informed decision making

The double burden of malnutrition, i.e. the coexistence of undernutrition (stunting and wasting) alongside overnutrition (overweight and obesity) is prevalent throughout Africa (Rockström et al. 2025). In order to feed a growing population with a healthy diet within planetary boundaries, Africa needs to produce more food (Rockström et al. 2025). Currently the continent is still dependent on food imports such as cereals, especially in countries such as Egypt (Mamboundou and Traoré 2026). Volatile markets and food import dependency significantly affect food security across Africa. On the other hand, many African farmers produce cash crops for export to bring in revenue.

Food production needs to occur within planetary boundaries, as available water resources are limited (Vanham et al. 2021). Cropland expansion should be reduced to a minimum, as this often goes at the expense of natural ecosystems like forests and grasslands (Ngoma et al. 2021; Khan et al. 2025), which provide essential ecosystem services for humans, including for local populations. As in many African regions crop yields are low, much extra food can be produced by closing yield gaps

Sorghum farming in Wechiau Upper West Region Ghana
(*photo:* Augustus Addo/IWMI)

(Mueller et al. 2012). Expanding irrigation on currently rainfed cropland is an important strategy to do so (Rosa et al. 2020), taking into account local water availability and the water use of other sectors.

For informed decision making, there is a need for reliable, findable, high-quality, open access and spatially distributed data on crop specific water use. Currently there is a persistent lack of reliable water data (IWMI and CGIAR System Organization 2024), especially sectoral water use data in the Global South. To address this gap, IWMI researchers collaborated with IHE-Delft in the Netherlands as well as the University of Alabama in the USA to provide crop blue and green water consumption (WC) amounts for 46 different crops in a spatial resolution of 10 kilometers covering Africa. The results and database are published and made available open access in the scientific journal Nature Food (Chukalla et al. 2025a, 2025b).

The different definitions of "water use"

Many different definitions of water use exist, sometimes leading to confusion when they are not properly defined and applied. "Water use" is a generic term that can mean either water consumption (WC) or water withdrawal (WW)(Figure 1). WW refers to blue water withdrawal for an economic activity, while blue water refers to water in rivers, lakes, wetlands and aquifers (Box 1). Blue WC refers to the portion of blue WW that is not returned to the original water source after being withdrawn. Blue WC equals WW minus return flow (Figure 1). Crops also evapotranspirate soil water as green WC (Box 1).

Irrigation efficiency is the ratio between irrigation blue WC and WW (Figure 1). Water productivity (WP) refers to crop output per m³ water used, measured as physical WP (kg per m³), economic WP ($ per m³) or nutritional WP (calorie, proteins or fat per m³). The water footprint (WF) is a widely used indicator and refers to the WC per crop output, generally measured as m³ per ton or litres per kg.

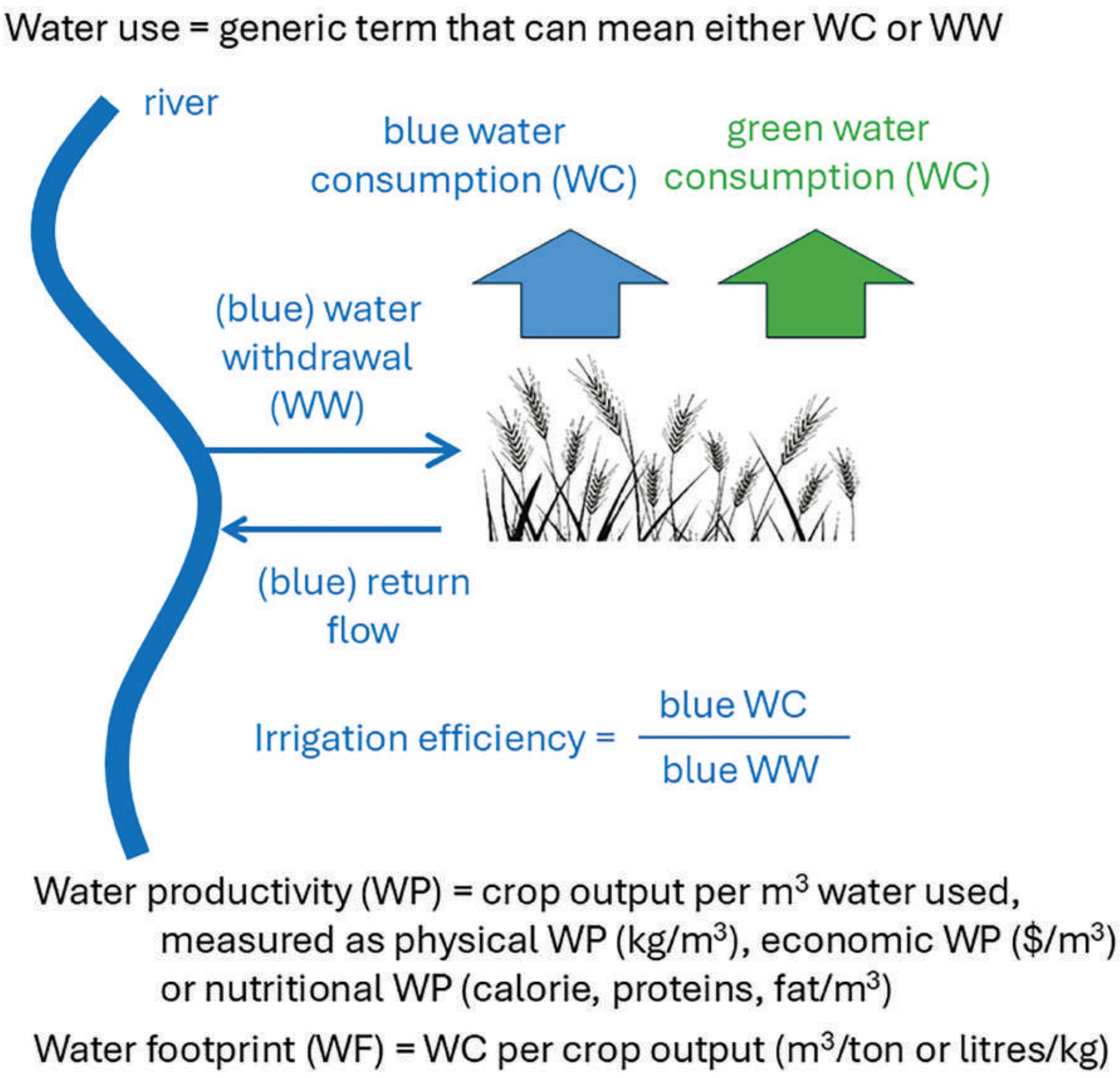
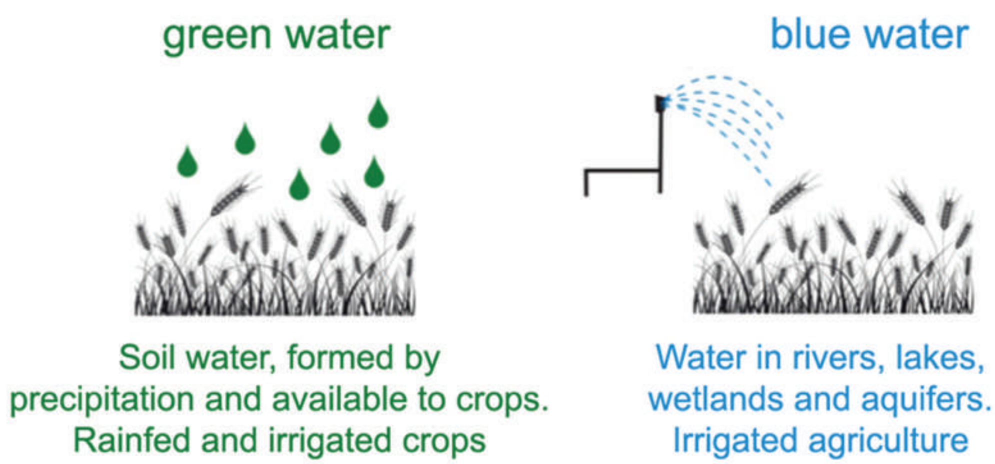


Figure 1. Overview of different definitions on water use. (*source:* IWMI)

Box 1: Blue and green water

Agriculture is the largest water user worldwide, both in terms of blue and green water (FAO 2020). Blue water refers to water in rivers, lakes, wetlands and aquifers. Green water is the soil water held in the unsaturated zone, originating from precipitation and eventually evaporating through and from plants and soils (Wang-Erlandsson et al. 2022; Schyns et al. 2019). Irrigated agriculture receives blue water (from irrigation) as well as green water (from precipitation), while rainfed agriculture receives only green water. Other sectors such as domestic water supply, industries, and power plants use only blue water resources. In international reporting and statistics, such as in Aquastat of the FAO (FAOSTAT 2025), blue water is the main component of interest (Vanham et al. 2018).



BOX 2: IWMI's new crop water use model *CropGBWater* and resulting open access database

IWMI and partners have quantified the blue and green water consumption (WC) of crop production in Africa for the years 2020 and 2010, in a high spatial resolution of 10 km, for 46 individual crops. *CropGBWater* has been designed for use by any stakeholder with basic modelling skills, using only open-source input data. The model and results are published in the high profile scientific journal Nature Food (Chukalla et al. 2025a) and made freely available to any stakeholder on the repository Zenodo https://doi.org/10.5281/zenodo.13901563 (Chukalla et al. 2025b).

Green and blue crop water consumption (WC) and crop water footprints (WFs) in Africa in the year 2020

Blue and green WC for 46 crops covering Africa amount to 119 km³ and 1,087 km³, respectively, adding up to 1,206 km³ (Figure 2). Blue WC is concentrated in a few countries, most notably Egypt, Sudan, Morocco, Nigeria, Mali, Madagascar and Algeria, whereas green WC is spread more over the continent. This assessment confirms that African crop production is primarily rainfed, whereas the potential for additional irrigation to close yield gaps is high (Rosa et al. 2020).

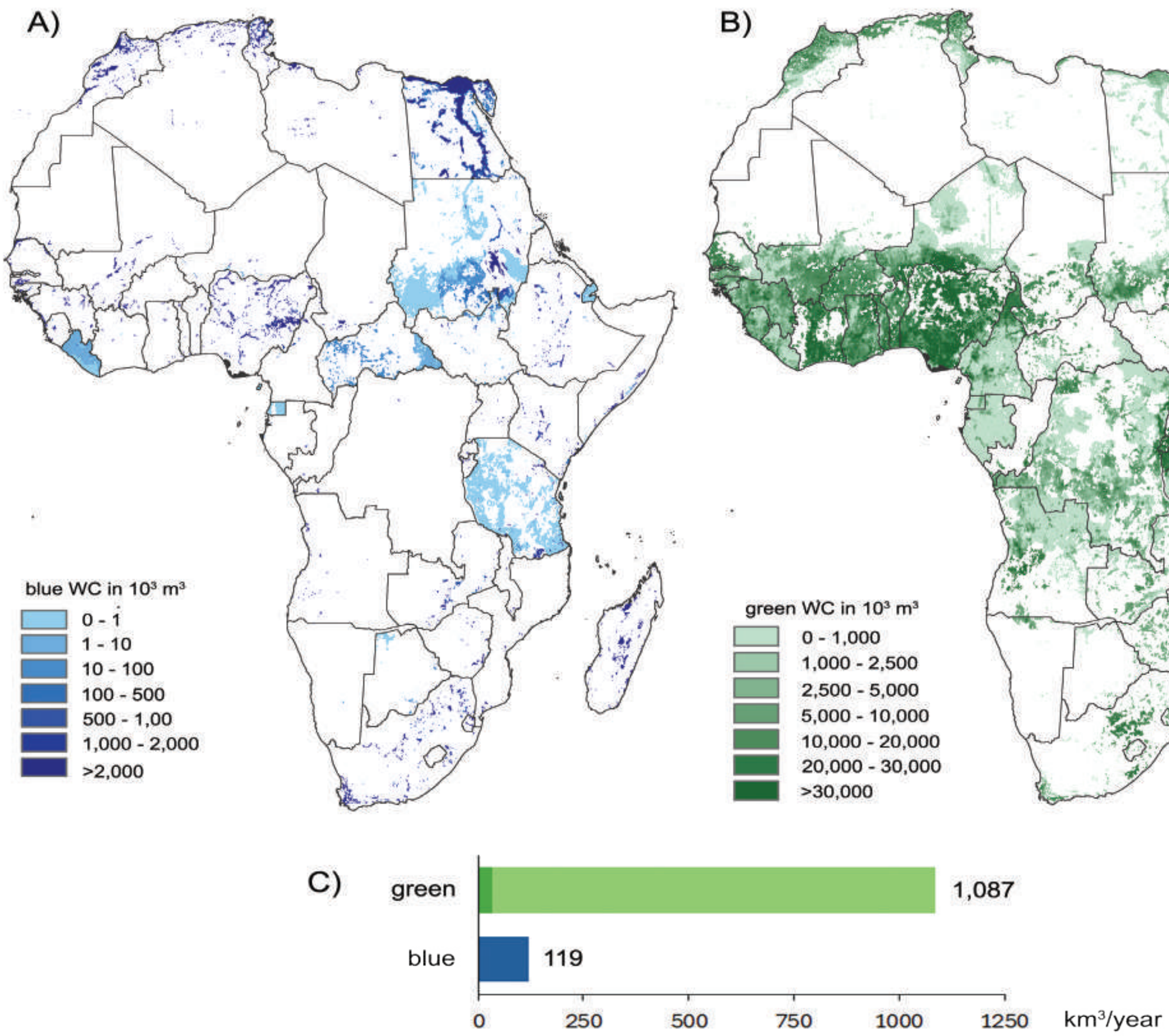


Figure 2. Green and blue WC in Africa for the year 2020, for all 46 crops combined, with A) map of blue WC distribution in Africa; B) map with green WC in Africa and C) Overall values being 119 km³ for blue water and 1,087 km³ for green water (with 1,055 km³ for rainfed green WC, displayed in lighter green, and 32 km³ for irrigated green WC, displayed in darker green).(*source:* IWMI)

The crop accounting for the highest total WC amount is maize, a main staple food in many African regions (181 km³, 13 km³ blue and 168 km³ green)(Figure 3). In 2020, the harvested area of maize in Africa was 41 million hectares (Mha), of which 39 Mha were rainfed and only 2 Mha were irrigated. High WC amounts for maize are observed in countries such as Angola, the DRC, Egypt, Ethiopia, Nigeria, South Africa and Tanzania.

Maize is followed by sorghum (105 km³, 2 km³ blue and 103 km³ green) and rice (98 km³, 27 km³ blue and 72 km³ green), where the researchers accounted for the flooding phase of paddy rice. Rice uses the most blue water of all crops. High WC amounts for rice are observed in the DRC, Egypt, Guinea, Madagascar, Mali and Nigeria. Also wheat shows a high blue WC of 13 km³. Crops that are grown throughout Africa under primarily rainfed conditions with high WC amounts include cassava, pearl millet, groundnuts, plantains, oilpalm, cowpeas and yams.

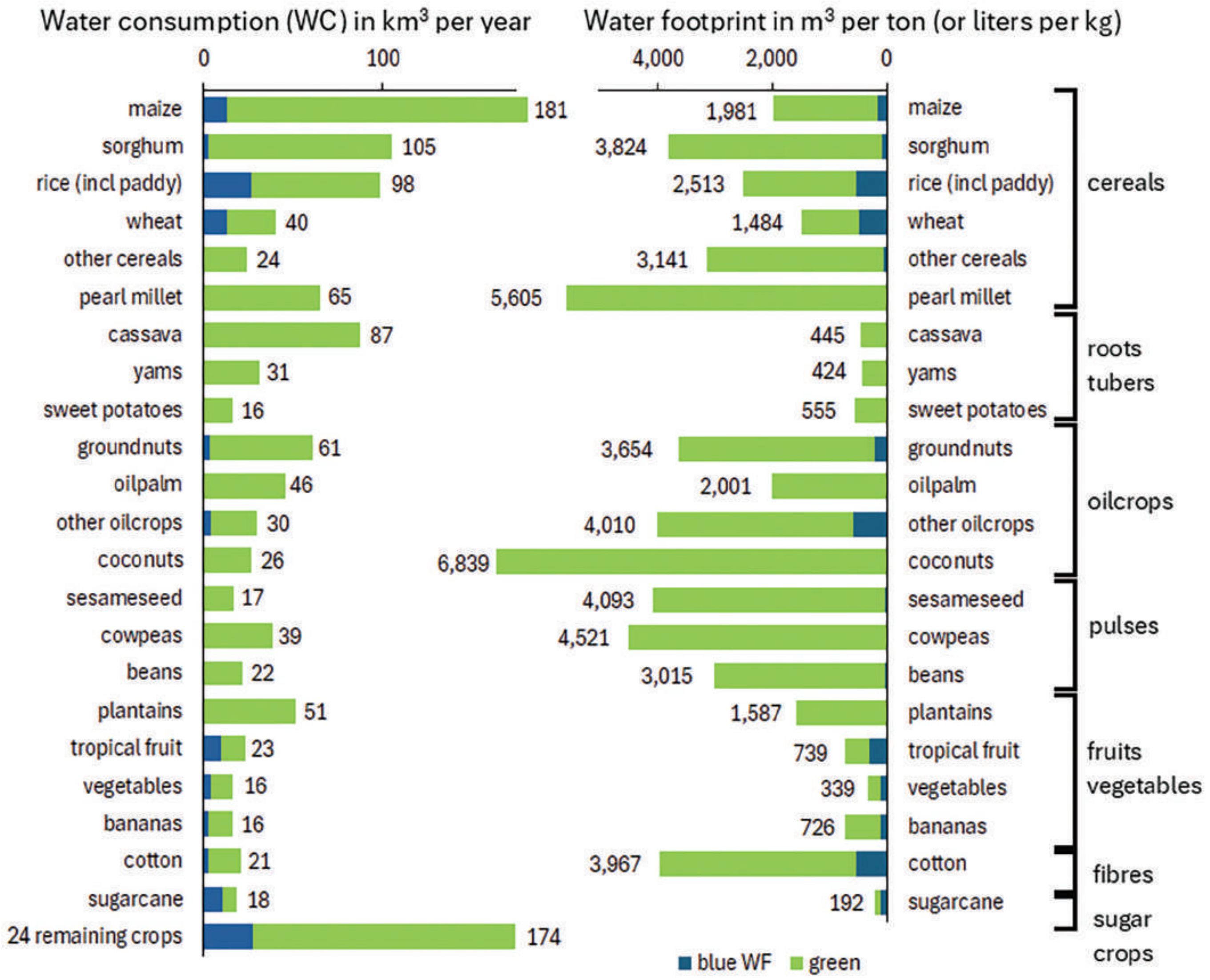


Figure 3. (Left) Twenty-two crops with the highest total WC (blue plus green WC) in km³ in the year 2020. The 24 remaining crops include tomatoes, plantains and citrus, which are not included in the groups “vegetables” or “tropical fruit”. (Right) The (green plus blue) water footprint of the same crops (in m³ per ton) for the year 2020, sorted according to main food groups

The water footprint (WF) of the same crops (right side of Figure 3) shows the African average blue plus green WC per crop output. Cereals have relatively high WFs (range 1,500-5,000 m³ per ton), with especially rice and wheat showing large blue WFs (519 and 466 m³ per ton, respectively). Roots and tubers (cassava, yams and sweet potatoes) show considerably lower WFs within the range 400-500 m³ per ton. This means it takes much less water to produce the same quantity of these crops compared to cereals. The WFs of oilcrops (range 2,000-7,000 m³ per ton) and pulses (range 3,000-4,500 m³ per ton) are also high. The WF of fruits and vegetables is much lower (range 300—1,600 m³ per ton), although their blue WF tends to be higher than crops from other food groups. Cotton has a high total and blue WF. Sugarcane on the other hand has with 192 m³ per ton a very low WF.

Crop blue water withdrawal (WW) in Africa in the year 2020

Blue water withdrawal (WW) for irrigation is a common statistic provided by FAO's Aquastat on the national level. The researchers quantified a total African amount of 225 km³ in 2020 (Figure 4). With a blue WC of 119 km³, this means that the African average irrigation efficiency is 53%. Latter value is however highly heterogenous in terms of geography and local irrigation system.

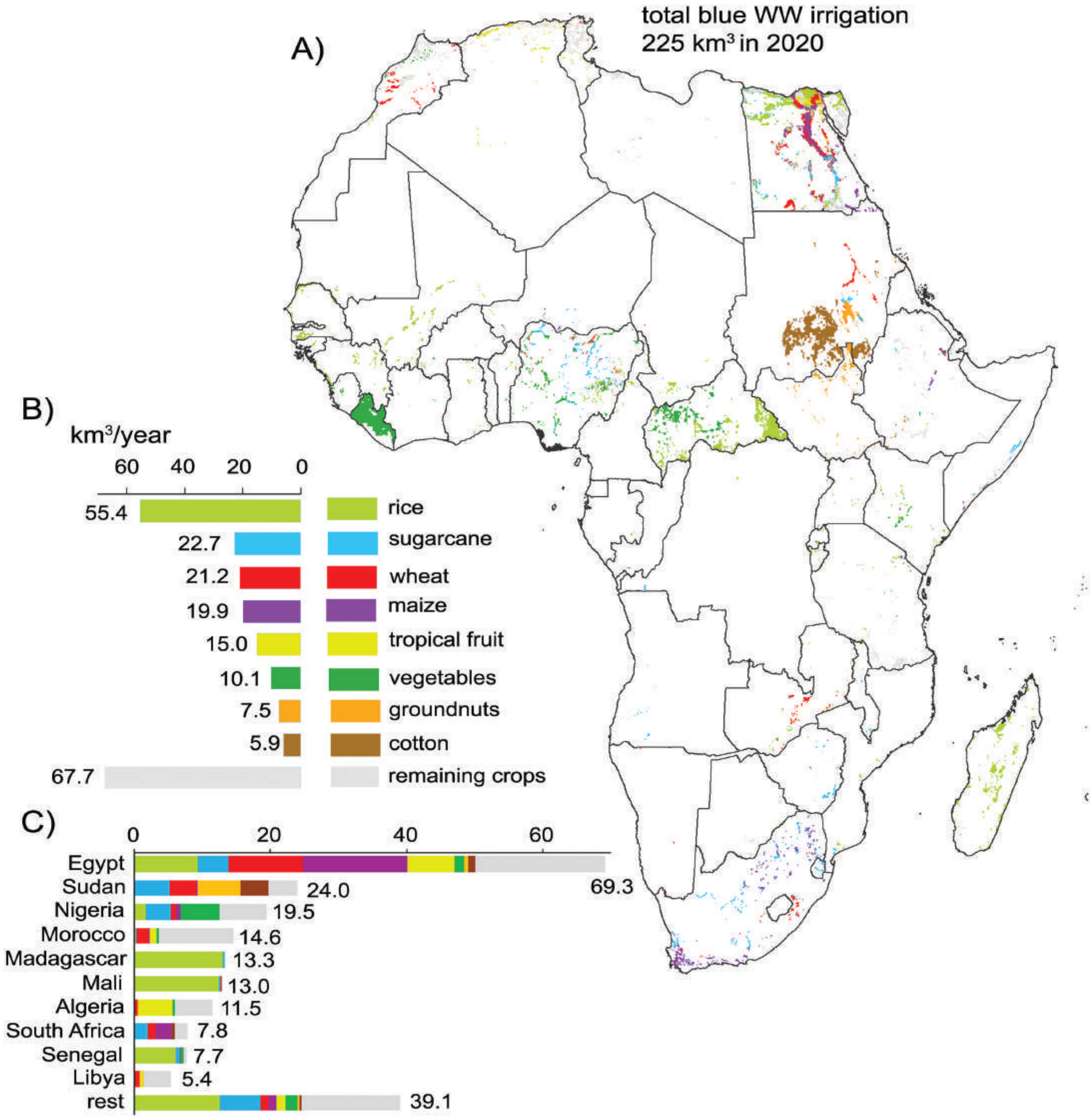


Figure 4. Irrigation blue WW (in km3) in Africa for the year 2020, with A) High spatial resolution map showing the crop with the highest WW in a grid cell, for rice, sugarcane, wheat, maize, tropical fruit, vegetables, groundnuts and cotton; B) The overall total WW amount of these selected crops in Africa; C) Countries with the highest total WW amounts with identification main crop WW amounts

BOX 3: African average irrigation efficiency is estimated at 53%, with large regional variations

Irrigation efficiency (IE) is the ratio between irrigation blue WC and WW. Average African IE is estimated at 53%, but ranges from very high amounts of 80-90% in the Nile river delta to low amounts for inefficient irrigation systems. IE is dependent on both conveyance efficiency (loss in canals) as well as field efficiency, subject to the field irrigation type such as flood, sprinkler, or drip irrigation systems. IEs in this study are best estimates based on multiple sources including local studies, recognizing IE amounts have a high level of uncertainty. In order to save water, it is imperative to increase IEs, for example by switching from sprinkler to drip irrigation on an agricultural field. However, such interventions always need to be accompanied by measures such as putting a cap on WWs for individual farmers in the river basin (Grafton et al. 2018)

The crops with the highest blue WW are in decreasing order rice, sugarcane, wheat, maize, tropical fruit, vegetables, groundnuts and cotton (Figure 4B). Irrigation for these crops occurs in multiple places throughout Africa (Figure 4A and 4C), but some main patterns are visible. Rice is irrigated in high quantities in Egypt, Madagascar, Mali, Nigeria and throughout western Africa. Sugarcane is irrigated in high quantities in Egypt, Sudan and South Africa, whereas for wheat this is particularly the case in Egypt, Sudan and Morocco and for maize Egypt and South Africa. Tropical fruit is highly irrigated in Egypt and Algeria and vegetables in Nigeria. Sudan is a hotspot for the irrigation of groundnuts and cotton.

Increase in crop water use from 2010 to 2020

Both rainfed and irrigated crop production and resulting WC increased from 2010 to 2020, from 1,051 km³ to 1,206 km³ (Figure 5A). This increase is primarily driven by an increase in harvested areas. African harvested area grew from 224 million hectares (Mha) in 2010 to 274 Mha in 2020 (IFPRI 2025; FAOSTAT 2026), an increase particularly driven by harvested area expansions in cassava, groundnuts, maize, plantains, rice and yams.

While African diets have historically relied on staple crops such as maize, cassava and sorghum, there has been a shift towards preferences in rice consumption in especially western Africa and Madagascar, where per capita consumption now exceeds 100 kg annually (Yuan et al. 2024; FAOSTAT 2026). This increase in rice consumption has been met through a parallel increase in rice domestic production as well as imports from predominately Asia (FAOSTAT 2026). As rice is a crop with a high water footprint (Figure 3), its WC has increased substantially through Africa.

Increases in irrigated rice areas are associated with exposure to greater malaria risk (Chan et al. 2022), especially during the flooding phase. Much potential in reducing the water required for this flooding phase is provided by systems such as alternative wetting and drying, providing additional win-wins such as reduced malaria exposure (Chan et al. 2022).

Also the WC of cassava increased substantially. Due to its importance as a food security crop in Western, Central and Eastern Africa, large increases occur in this region, such as Nigeria, the DRC, Uganda, Tanzania, Angola and Ghana. Traditionally a famine reserve and a subsistence crop, the status of cassava is now evolving fast as a cash crop and as raw material in the production of starch (and starch based products), energy (bio-ethanol) and livestock feed in the major producing countries (Parmar et al. 2017).

Although in many African regions crop yields remain low compared to internationally attained yields, farmers have managed to increase overall crop yields throughout Africa from 2010 to 2020 (FAOSTAT 2026; Van Ittersum et al. 2025), by applying more fertilizers, using better seeds and expanding irrigation. Water productivity (WP) for all African crops has thereby increased from 0.6 to 0.7 kg per m³ for rainfed crops and from 1.5 to 1.6 kg per m³ for irrigated crops (Figure 5B) (Chukalla et al. 2025a, 2025b). For maize and sorghum as individual crops, both rainfed and irrigated WPs increased (Figure 5C and 5D). These amounts also clearly show the higher WP of an irrigated crop compared to the same rainfed crop.

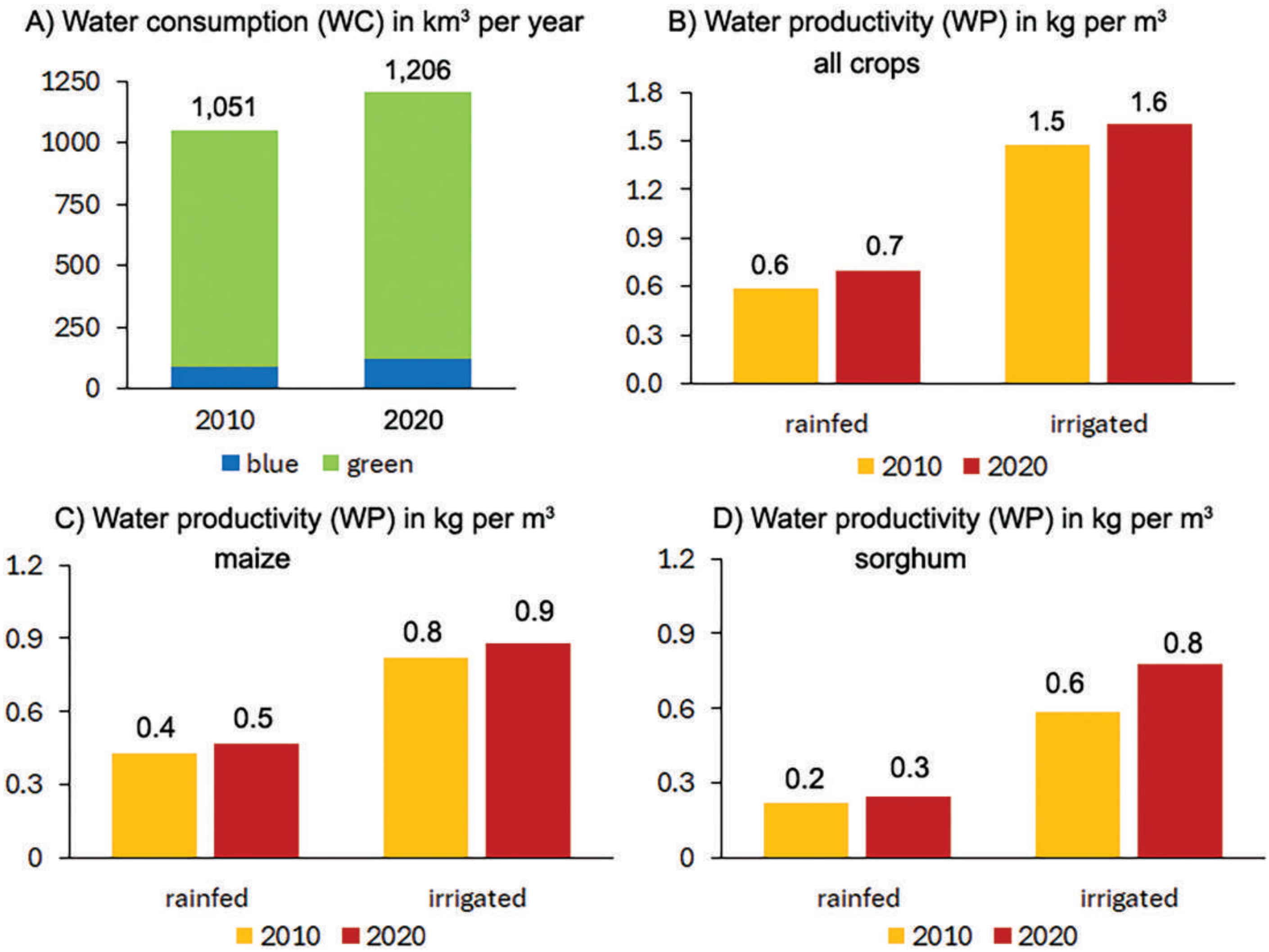


Figure 5. A) Blue and green water consumption (WC) for the years 2010 and 2020 (in km³ per year); B-D) Rainfed and irrigated water productivity (WP) for the years 2010 and 2020 (in kg per m³) for B) all crops; C) maize and D) sorghum. (*source:* IWMI)

BOX 4: Export of cash crops from African countries leads to virtual water exports

Cash crops, such as cocoa, cotton, coffee, tobacco, groundnuts, treenuts, certain fruits and vegetables, are not only consumed in Africa but their production is also driven by high export demand and profitability. Between 2010 and 2020, increased production has led to more overall fruit and vegetable consumption throughout Africa (FAOSTAT 2026). A substantial part has also been used for export, resulting in so-called virtual water export, both inside (between African nations) and outside of the continent (Vanham et al. 2023). The export of cash crops includes bananas from Côte d'Ivoire and Cameroon, citrus fruit and grapes from South Africa and northern Africa (FAOSTAT 2026), groundnuts from South Africa and Sudan or tomatoes from Morocco, often contributing to local water stress (Vanham et al. 2020). Although important for income generation (Mamboundou and Traoré 2026), a careful trade-off needs to be made between farmer income, crops contributing to water stress as well as food self-sufficiency.

Recommendations

Crop production and resulting water use have increased substantially from 2010 to 2020, driven by population increase, economic growth, changing diets and consumer preferences (Dossou-Yovo et al. 2022; FAOSTAT 2026). Yet, low yields and a lack of sufficient investment in storage and processing has increased demand for imported food (Mamboundou and Traoré 2026). Large yield gains are needed to avoid further import dependency and cropland expansion which is detrimental for biodiversity and greenhouse gas emissions (Van Ittersum et al. 2025). Expanding irrigation in a water smart manner to close yield gaps is of highest priority. Also the increase of irrigation efficiencies can save much water, when applied in an integrated river basin management setting.

However, such interventions and related policies need to be embed nexus thinking. Coordination and collaboration between different ministries and stakeholders is required, thereby aligning policies on agriculture, water, energy (Vaca-Jiménez et al. 2026), health, industry, trade and the environment (Vanham et al. 2021). Policies also need to address cooperation and river management across borders (Basheer et al. 2023). As an example, large parts of the population in African countries do not eat recommended amounts of fruit and vegetables, depriving them from essential nutrients (FAOSTAT 2026; Rockström et al. 2025; Wyma et al. 2025; Herforth et al. 2019). African farmers have increased domestic fruit and vegetables production from 2010 to 2020, resulting in substantial water use increases but also more overall fruit and vegetable consumption throughout Africa (FAOSTAT 2026). Yet, substantial amounts of fruit and vegetables are produced under water stress and a proportion are exported as cash crops outside of the continent, including to Europe, the Middle East and Asia. Policies and strategies need to carefully evaluate such trade-offs and identify win-wins.

The water footprint of crops needs to be accounted for. In water scarce basins, shifting to crops that have a lower water footprint, for example cassava instead of rice, might be a strategy to lower overall water use within a basin to sustainable levels.

Policies should be data and science based. This new openly accessible dataset on crop specific water use as well as the model to compute them can act as a valuable resource for informed decision making.

Solar powered drip irrigation in Zimbabwe (*photo:* David Brazier/IWMI)

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Water pumped by a diesel-powered system supports an irrigation project near Ziway, Ethiopia (*photo:* Petterik Wiggers/Panos Pictures UK for IWMI).

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